Remarks

The following comments are provided in support of the claims presented. Applicants respectfully request reconsideration of the claims and entry of the amendments presented herein as being necessary to place the application into condition for allowance or appeal.

1. § 103 Rejection

Claims 1-23 have been rejected under 35 U.S.C. § 103(a) as being obvious in view of Lebby (US 5,956,363) and Brillouet (US 6,052,398).

As amended herein, independent Claims 1 and 13 recite a first mirror and a second mirror both of which are "n-type" mirrors with the same doping type. Applicants respectfully submit that this essential claim limitation of Claims 1 and 13 would not be present in any device formed by combining the tunnel junction of Brillouet with the vertical cavity surface emitting laser (VCSEL) of Lebby as suggested by the Office since Lebby teaches a requirement for two mirrors of opposite doping type (i.e. one mirror being n-type doped and the other mirror being p-typed doped). This requirement in Lebby for two mirrors of different doping types is explicitly stated in col. 5, lines 1-6:

> Doping of stack 14 and 26 of distributed Bragg reflectors is achieved by using any suitable n-type dopant and p-type dopant, respectively. However, it should be understood that while on[e] of stacks 14 and 26 of distributed Bragg reflectors will be selected as being p-type doped, the other stack 26 and 14 will be n-type doped.

and again in col. 5, lines 14-18:

> To complete VCSEL 10, a p-contact layon mirror stancioned on mirror stack 26, and a n-contact layer 46 is positioned on substrate 12, for example on the rear surface thereof, when mirror stack 26 is p-type dope[d] and mirror stack 14 is n-type doped.

and yet again in col. 6, lines 29-34:

> Various changes and modifications to the embodiments herein chosen for purposes of illustration will readily occur to those skilled in the art. For example, it should be understood that VCSEL structure symmetry exists for both the p and n dopants as well as electrically inverted structure designs.

Based upon this explicit disclosure in Lebby for one mirror being n-type doped and the other mirror being p-typed doped, Applicants respectfully traverse the statement by the Office on page 2 of paper no. 12 that "The first and second mirrors are unipolar distributed Bragg reflectors that are n-type (col. 5, lines 1-3)" and the statement on page 4 that Brillouet and Lebby "have primarily the same structure." The above statements from Lebby clearly show that the VCSEL device of Lebby contains two mirrors of opposite doping types, with one mirror being n-type doped and with the other mirror being p-type doped so that the structures of the devices of Lebby and Brillouet are clearly not the same. Applicants respectfully submit that, even if one skilled in the art were motivated to combine the tunnel junction of Brillouet into the VCSEL of Lebby as suggested by the Office, the result would necessarily be a VCSEL having one n-type mirror and another p-type mirror as required by Lebby, and this is contrary to Applicants' claimed invention, as amended herein, which requires two n-type mirrors. Therefore, Applicants respectfully submit that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claims 1-23 based on the combination of Lebby and Brillouet.

Applicants further submit that one skilled in the art would not be motivated to insert a tunnel junction as disclosed by Brillouet into the device of Lebby since the VCSEL of Lebby, which is formed on a GaAs substrate without any tunnel junction, is fully operational and functional for its intended purpose so that the modification suggested by the Office is not necessary. Lebby cite no impediment to current flow into the active region; and one skilled in the art would recognize that no such impediment exists in the device of Lebby which is formed with a p-n junction about the active region. Although Brillouet may disclose an impediment to current flow into the active region, this impediment to current flow is the result of having a completely different device structure with two n-type mirrors so that a p-n junction is not formed about the active region until a tunnel junction is provided. Without the tunnel junction in Brillouet, the impediment to current flow arises since each mirror is n-type doped with electrons as the majority carriers so that there is no source of a hole current to flow into the active region and recombine therein with electrons to

produce optical gain for lasing. The tunnel junction in Brillouet remedies this situation by providing a source of holes in a side of the device which is otherwise completely n-type doped.

The addition of the tunnel junction in Brillouet results in an additional potential drop which Brillouet states is not "troublesome" (see col. 5, lines 6-10) in view of other benefits to be gained by the structure of Brillouet which is different from that of Lebby. Thus, Applicants urge that the motivation cited by the Office ("to allow the pumping current to be conducted to the active region without a substantial potential drop" as stated on page 3 of paper no. 12) would not lead one skilled in the art to insert a tunnel junction into the VCSEL of Lebby since no tunnel junction is needed in Lebby's structure and since no advantage would be gained by doing so. To the contrary, adding the tunnel junction of Brillouet to the VCSEL of Lebby would result in an increased potential drop as compared to the fully functional device of Lebby without the tunnel junction so that performance would be degraded. Thus, Applicants respectfully submit that the Office has not shown the requisite motivation required for a valid *prima facie* case of obviousness based on the combination of Lebby and Brillouet.

Additionally, the tunnel junction disclosed by Brillouet is formed from InGaAsP for use with a VCSEL fabricated on an InP substrate and further having an InGaAsP active region and InP/InGaAsP mirrors (see col. 5, lines 29-32 and col. 4, lines 12-43). As an alternative for the top mirror, Brillouet cites the use of a GaAs/ AlGaAs top mirror which must be added to the structure by wafer bonding (i.e. "wafer fusion") since such mirror results in "a crystal lattice that does not match that of the indium phosphide chip" (see col. 6, lines 1-10). Lebby teaches against the use of an InGaAsP active region and InP/InGaAsP mirrors on an InP substrate since "it is practically impossible to achieve decent DBR based mirrors because of the insignificant difference in the refractive indices in this material system" (see col. 1, lines 43-49). Lebby further teaches against the use of wafer fusion since "the interface defect density in the wafer fusion procedure causes potential reliability

problems" (col. 1, lines 49-54). Therefore, Applicants urge that given the teaching in Lebby against the use of an InP/InGaAsP material system as disclosed by Brillouet, one skilled in the art would not be motivated to modify the fully functional VCSEL of Lebby by inserting the InGaAsP tunnel junction as disclosed by Brillouet. The teaching in Lebby against the use of the InP/InGaAsP material system provides further evidence that one skilled in the art would not be motivated to insert the tunnel junction of Brillouet into the VCSEL of Lebby as suggested by the Office.

With regard to Claim 4, the Office states on page 3 of paper no. 12: "The combination of Lebby and Brillouet inherently forms a device in which the tunnel junction is positioned at or near a standing wave null in the optical field because the combined components have the same structure and materials as the applicant's claimed invention." Applicants respectfully traverse this statement by the Office since Applicants' unipolar device structure with two n-type mirrors as recited in amended Claims 1 and 13 is different from the bipolar device structure that would result from the insertion of the tunnel junction from Brillouet into the VCSEL of Lebby which would have one n-type mirror and another p-type mirror. Additionally, the materials used in Applicants' invention are different from the materials that would result from the combination of Brillouet with Lebby. In particular, Brillouet discloses a tunnel junction formed from InGaAsP (see col. 5, lines 29-32) with no teaching or suggestion for the use of any other material for the tunnel junction; whereas Applicants disclose that the tunnel junction is formed from completely a different material GaAs (see page 5, lines 11-15). Therefore, Applicants urge that the combination of Brillouet and Lebby would not "inherently" form a VCSEL having the tunnel junction "positioned at or near a standing wave null in optical field" as required by Claim 4, so that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claim 4 based on inherency.

With regard to Claims 7 and 18, these claims recite the essential claim limitation of an oxide aperture comprising "a carbon doped spike positioned at or near a standing wave null in optical field." The Office has not shown in paper no. 12

where either Brillouet or Lebby teach or suggest the use of "a carbon doped spike" in any oxide layer with the "a carbon doped spike" being "positioned at or near a standing wave null in optical field" as required by Claims 7 and 18. The passage (col. 5, lines 1-3) cited by the Office on page 3 of paper no. 12 for disclosure of doping of oxide aperture layers has nothing at all to do with such oxide layers, but instead refers to "Doping of stack 14 and 26 of distributed Bragg reflectors..." which are the mirrors and not the oxide aperture layers. Therefore, Applicants respectfully submit that the Office has not made a valid *prima facie* case of obviousness for the rejection of Claims 7 and 18 so that these claims are allowable.

With regard to Claim 9, this claim as recites that the first and second mirrors comprise "unipolar distributed Bragg reflector mirrors." As stated above, Lebby does not disclose "unipolar distributed Bragg reflector mirrors" but to the contrary discloses bipolar distributed Bragg reflector mirrors with one mirror being n-type doped and with the other mirror being p-type doped. Therefore, Claim 9 is allowable.

2. Other Matters

Amendments are presented herein to Claims 5-9 and 11-12 to change "vertical cavity surface emitting layer" to "vertical cavity surface emitting laser" in conformance with independent Claim 1. These amendments are necessary to a provide proper antecedent basis for dependent Claims 5-9 and 11-12.

Conclusion

Applicants have responded to each and every rejection and objection, and urge that the Application is in condition for allowance. A favorable reconsideration and entry of the amendments presented herein is earnestly solicited in order to place the application into condition for allowance or appeal.

Respectfully submitted,

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John P. Hohimer
Patent Attorney, Reg. No. 39,226
Sandia National Laboratories
Patent & Licensing Center, MS 0161
P. O. Box 5800
Albuquerque, New Mexico 87185-0161
Phone: (505) 844-4007
FAX: (505) 844-1418

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